A Deduction from the Cuantex Model of the Elementary Particle: Transmutation of Elementary Particles in the Presence of High Electric Fields

Juan Carlos Alcerro Mena

Mathematics Department, Universidad Cristiana Evangélica Nuevo Milenio.
Faculty of Engineering, Universidad Jesús de Nazareth.
Mathematics Department, Universidad de San Pedro Sula.

Email: juancalcerro@hotmail.com, jc.alcerro@ujn.edu.hn, j.alcerro@ucenm.net, 118014@usap.edu

Abstract: ***The present document reports the theoretical results obtained when modeling, by means of the expression for the Four-force of the cuantex model of the elementary particle (particle model of the Euclidean equivalent of Minkowski's space time), the action of the electric field on an elementary particle. Its most important result is that given certain very high values of the electric field, an electron immersed in that field can become a photon, a positron or other particles and antiparticles of the lepton group.***

Keywords: Cuantex model, Leptons, Electric fields, Transmutations, Antimatter

1. Introduction

The cuantex model of the elementary particle[1] [1] leaves open a wide range of research paths that can lead to improve the current theoretical constructs in physics and to formulate new hypotheses. In this document the research question is posed: What results are produced when adjusting the Lorentz four-force to the cuantex model? In this paper we report the development of the model of this four-force to discover its results and answer this research question.

2. Some Concepts

Lorentz four-force of the Minkowski space time

The following is the four-force of Minkowski space time [2]:

$$\mathbf{F_{4R}} = \gamma F_1\, \hat{\imath} + \gamma F_2\, \hat{\jmath} + \gamma F_3\, \hat{k} + i\gamma F_1\,(v/c)\, \hat{\omega} \qquad \textbf{(1)}$$

Where:

F_1, F_2 and F_3 are the components in x_1, x_2 and x_3 respectively, i is the imaginary unit.

$\hat{\imath}$, $\hat{\jmath}$, $\hat{k}$ and $\hat{\omega}$ are the unit vectors on the x_1, x_2, x_3 and ict axes respectively and the particle motion is on the x_1 axis.

v: is the speed with which it moves.

γ : is the relativistic factor and is equal to $\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$

The expression (1) refers to forces in general, however, the following is the Lorentz four-force of Minkowski's space time (special case of (1) in which the action of an electromagnetic field on a charged particle is modeled), written in matrix form:

$$\begin{bmatrix} \gamma\, q\, E_1\, \hat{\imath} \\ \gamma\, q\, (E_2 - B_3 v_1)\, \hat{\jmath} \\ \gamma\, q\, (E_3 + B_2 v_1)\, \hat{k} \\ i\gamma\, qE_1\, v_1/c\, \hat{\omega} \end{bmatrix} \qquad \textbf{(2)}$$

Where always the movement is in x_1 and where E_1, E_2 and E_3 are the components of the electric field. B_2 and B_3 are the components of the magnetic field are the components of the magnetic field at x_2 and x_3. v_1, v_2 and v_3 are the components of the velocity of the charged particle and q is the electric charge of the particle.

Four-force of the Cuantex model[2]

The four-force of the cuantex model [1], is given by:

$$\boldsymbol{F} = F_1\, \hat{\imath} + F_2\, \hat{\jmath} + F_3\, \hat{k} + (F_1^2/\gamma^2 + F_2^2 + F_3^2)^{1/2}\, \hat{\alpha} \qquad \textbf{(3)}$$

Where $F_1^2/\gamma^2 + F_2^2 + F_3^2$ is the invariant of (1) in a Minkowski space time coordinate change, multiplied by the factor $1/\gamma^2$, F_1, F_2 and F_3 are the components in x_1, x_2 and x_3 respectively, respectively, $\hat{\alpha}$ is the unit vector of the compact axis in the fourth dimension and where the axis x_1 is the axis where the movement of the particle occurs.

Lorentz four-force of the Cuantex model

By applying expression (3) to expression (2), with v_1 as the only component for the velocity, we obtain the following Lorentz four-force of the cuantex model:

$$\begin{bmatrix} q\, E_1\, \hat{\imath} \\ q\, (E_2 - B_3 v_1)\, \hat{\jmath} \\ q\, (E_3 + B_2 v_1)\, \hat{k} \\ q\,[\, E_1^2/\gamma^2 + (E_2 - B_3 v_1)^2 + (E_3 + B_2 v_1)^2\,]^{1/2}\, \hat{\alpha} \end{bmatrix} \qquad \textbf{(4)}$$

[1] For a better understanding of this document, read the article cited.

[2] This is the four-force of the Euclidean equivalent of Minkowski's space-time.

Where the x_4 component contains a square root that implies the option of taking a positive or negative sign, in this document we analyze only the case where the magnetic field is null, so that the net sign of the fourth component is a function of the laws of attraction and repulsion and of action and reaction. The following table[3] shows some configurations:

Table 1: Some configurations that define the sign of the fourth component of the Lorentz four-force of the cuantex model (4) for when the magnetic field is zero

Electric field source	Particle affected by the field	Effect	Sign to take
Positive charge	Electron	attraction	+
Negative charge	Positron	attraction	-
Capacitor	Electron	composite	+

Four-linear momentum of the Cuantex model.
The four-momentum of an elementary particle in the cuantex model [1], is given by:

$$\boldsymbol{P} = m_0u_1\gamma\ \hat{\imath} + m_0u_2\gamma\ \hat{\jmath} + m_0u_3\gamma\hat{k} + m_0c\ \hat{\alpha} \qquad \textbf{(5)}$$

Where:
m_0: is the rest mass of the elementary particle.
u_1, u_2, u_3: are the components of the particle velocity in x_1, x_2, x_3, respectively.

Transmuting effect of the fourth component of the four-force (3) of the cuantex model

From the above it was deduced that, if a force ***F*** is applied during a time interval on the elementary particle, then the fourth component of (3) modifies the fourth component of (5) and therefore the rest mass of the particle, in other words, ***F*** performs a transmutation on the elementary particle on which it is applied. Since there is a discrete number of types of elementary particles in the universe, as ***F*** increases, a discrete transmutation is made on the particle, leading it to obtain only the possible rest masses.

Fourth compact dimension of the cuantex model

The spatial topology (disregarding the time dimension) of the Euclidean equivalent of Minkowski spacetime [1], which underlies the cuantex model, is of the type $M^3 \times S^1$, that is, it implies a compact dimension. In relation to this, the figure 1 is an overview that shows the relationship between the resting masses of leptons and the radius d of the compact dimensions through which their cuantex photons transit.

In relation to this figure, the following is the identity that relates the radius d that forms the circle of the compact dimension with the rest mass of the elementary particle [1]:

$$d = (1/2\pi)\ (h/m_0c) \qquad \textbf{(6)}$$

Where:
d: is the radius of the compact dimension (see figure 1).
h: is Planck's constant.

[3] This is the result of an analysis that was made of attraction/repulsion and action-reaction in the compact dimension.

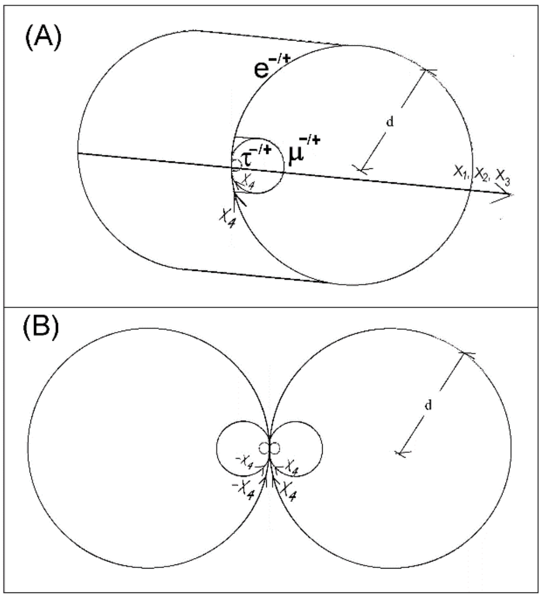

Figure 1: (Note: zooming is recommended):
(A)- Four-dimensional space, where x_1, x_2, x_3 are the axes of the extended three-dimensional space and X_4 is the axis of the fourth spatial dimension, which is compact. When the compact axes of the three leptons are plotted, three cylindrical shells are observed which coincide in the x_1-x_2-x_3 space. Here it is observed that the radius d of the circles of the compact dimensions of the electron (e-) and positron (e+), of the muon (μ^-) and anti-muon (μ^+) and the tau (τ^-) and anti tau (τ^+) they go in descent and opposite to the ascending order of their masses at rest (the expression 6 explains this) and where it is noticed that these proportions in figure 1 do not keep the exact scale since this would make the drawing difficult.
(B)- Front view of the cross section of the cylindrical shells where the negative compact shafts are added.

On the other hand, in the following table 2 are shown some characteristics of the electron and positron cuantex photons motion:

Table 2: Some characteristics of electron and positron cuantex photon rotation

Particle	Compact axis	Intrinsic angular momentum	Rotation in the compact axis
Electron	Positive	Positive	Counterclockwise direction
Electron	Negative	Negative	Clockwise direction
Positron	Positive	Negative	Clockwise direction
Positron	Negative	Positive	Counterclockwise direction

The above table applies equally to muon and tau with their respective antiparticles.

On the other hand, figure 2, shown below, focuses only on a determined type of elementary particle, unlike figure 1, and shows the four-force (3) applied on an elementary particle and it is also observed a reference frame is constructed whose origin is arbitrarily located in the center of the circle of the compact dimension (read description). This figure is appropriate for modeling the torques and angular moments implicit in the rotation of the cuantex photons, to which the elementary particles are equivalent, around the circle that forms the compact dimension (the X_4 axis in figure 1), here it is necessary to consider two extended dimensions (x_4-x_5, where x_4 should not be confused with X_4 because the latter refers to the compact axis) on which this circle is formed.

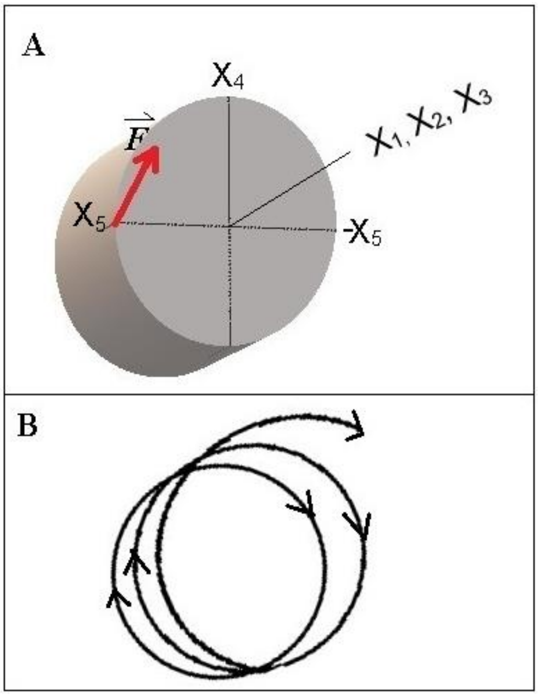

Figure 2

(A) Reference frame whose origin is in the center of the circle of the compact dimension and where the location of the cuantex photon to which the elementary particle is equivalent is given at the point of application of ***F***. This compact dimension requires two additional dimensions (x_4 and x_5) for its geometric representation in the figure. Note the arrangement of the positive and negative axis for x_5, this is for convenience to simplify the expressions later. The cylinder shown represents the movement of the cuantex photon to which the elementary particle is equivalent along a single axis in the three-dimensional space and the rotational movement in x_4 and x_5.

(B) When the cuantex photon, to which the elementary particle is equivalent, moves along a single axis in the three-dimensional space, then its trajectory is given in the surface of the cylinder shown in the figure, if the electric charge of the elementary particle is positive then it moves clockwise with respect to the cross section of the cylinder shown (this is the case in the figure) and if its charge is negative then it moves in the opposite direction.

General definition of torque and angular momentum of a particle

The following is the general definition of torque:

$$\tau = \mathbf{R} \times \boldsymbol{F} \quad \textbf{(7)}$$

Where:
τ: is the torque of the applied resultant force.
F: is the applied force.
R: is the position vector of F with respect to the center of rotation.

On the other hand, the following is the general definition of angular momentum of a particle:

$$\mathbf{l} = \mathbf{r} \times \mathbf{p} \quad \textbf{(8)}$$

Where:
l: is the angular momentum of the particle.
r: is the position vector of the particle with respect to the center of rotation.
p: is the linear momentum of the particle.
On the other hand, it was also necessary to consider the following general expression of the torque as a function of the change in the angular momentum of the particle [3]:

$$\tau = dl / dt \quad \textbf{(9)}$$

Where:
l: is the angular momentum of the particle.
t: is the time during which the force is applied.

Virtual photon of the electromagnetic field

In particle physics, the particle that mediates the electromagnetic force between two charged particles is a virtual photon [4], which exists for a sufficiently small time so that its energy is less than or equal to the uncertainty of the energy of the system of which the charged particles are composed. In the course of this time interval, the photon goes from one charged particle to the other and ceases to exist.

3. Procedures, Results and Discussions

To be as clear as possible, it was decided to develop this section over four units, each of which shows the procedures performed, results and discussions for each of the following objectives:

1) Apply the expressions (7) and (8) for the cuantex photon, which is equivalent to an elementary particle with mass at rest, in the case shown in figure 2.
2) With the results of the previous objective and based on the transmutation effect of the fourth component of the four-force (3) of the cuantex model, find the electric field necessary to transmute an electron to a photon in three-dimensional space.
3) With the results of objective 1 and based on the transmutation effect of the fourth component of the four-force (3) of the cuantex model, find the electric field necessary to transmute an electron to a positron.
4) With the results of objective 1 and based on the transmutation effect of the fourth component of the four-force (3) of the cuantex model, find the electric field necessary to transmute an electron to an anti-muon.

Torque and angular momentum of the cuantex model

Procedure

1) To find an expression for the torque applied on the cuantex photon, to which an elementary particle is equivalent, the expression (7) was applied to the case of figure 2, decomposing it in trios of orthogonal axes (three-dimensional subspaces of the five-dimensional Euclidean space of Figure 2). In more detail, the vector product was made for subspace x_1-x_4-x_5, for subspace x_2-x_4-x_5, for subspace x_3-x_4-x_5 and for subspace x_1-x_2-x_3.

2) To find an expression for the angular momentum of the cuantex photon, which is equivalent to an elementary particle, the expression (8) was applied to the case of figure 2, decomposing it in trios of orthogonal axes as it was done in the previous step.

3.1 Results

1) From step 1 the following expression for the torque was obtained:

$$\boldsymbol{\tau} = (R_4F_5 - R_5F_4 + R_2F_3 - R_3F_2)\,\hat{\imath} + (R_4F_5 - R_5F_4 + R_3F_1 - R_1F_3)\,\hat{\jmath} + (R_4F_5 - R_5F_4 + R_1F_2 - R_2F_1)\,\hat{k} \quad \textbf{(10)}$$

Where:
R_1, R_2, R_3, R_4 and R_5 are the components in x_1, x_2, x_3, x_4 and x_5 respectively, of the position vector of the applied force ***F***, with respect to the origin located at the center of the circle of the compact dimension. F_1, F_2, F_3, F_4 and F_5 are the components in x_1, x_2, x_3, x_4 and x_5 respectively, of the applied force ***F***.

2) From step 2 the following expression for the angular momentum was obtained:

$$\mathbf{l} = (r_4p_5 - r_5p_4 + r_2p_3 - r_3p_2)\,\hat{\imath} + (r_4p_5 - r_5p_4 + r_3p_1 - r_1p_3)\,\hat{\jmath} + (r_4p_5 - r_5p_4 + r_1p_2 - r_2p_1)\,\hat{k} \quad \textbf{(11)}$$

Where:
r_1, r_2, r_3, r_4, r_5 are the components in x_1, x_2, x_3, x_4 and x_5 respectively, of the position of the cuantex photon, which is equivalent to the elementary particle, with respect to the origin located in the center of the circle of the compact dimension and p_1, p_2, p_3, p_4, p_5 are the components of the linear momentum in x_1, x_2, x_3, x_4 and x_5, respectively.

4. Discussions

1) Expressions (10) and (11) agree with the fact that one cannot generalize the vector product of two vectors to a Euclidean space of more than three dimensions [5]. This is related to the fact that the four subspaces of steps 1 and 2 are the only ones that could be formed because the fourth dimension $\mathcal{X}_4$ is compact and therefore x_4 and x_5 could not be presented separately in any subspace. Because of the compact nature, there are also no components of the vector product for x_4 and x_5.
2) Another thing regarding the method adopted in step 1 and 2, the reader can check this method by decomposing into a pair of dimensions (a plane) the vectors B and C of a vector product A = B x C in space and develop the new vector product in this plane and check that the result is the component in the missing dimension of the resulting vector A.
3) With respect to expression (6) it is observed that:

$$d^2 = R_4^2 + R_5^2 \quad \textbf{(12)}$$

and

$$d^2 = r_4^2 + r_5^2 \quad \textbf{(13)}$$

And if expression (9) is rewritten as:

$$\int_0^t \tau \, dt = l_f - l_i \quad \textbf{(14)}$$

Where:
t: is the time during which the force is applied.

Then expressions (6), (12) and (13) impose restrictions on (14) since the latter, due to (8) and (11), is a function of these. These restrictions, added to the fact that the period in which the cuantex photon is separated from the x_1-x_2-x_3 axis (three-dimensional space in figure 1) is when still is not "updated" the state of the elementary particle in the mentioned space[4], derives in that when in (14) it is wanted to model a transmutation or change of rest mass of the elementary particle, then t is restricted by:

$$t = \frac{h\,\gamma}{m_0\,c^2} \quad \textbf{(15)}$$

A reaction that transmutes the electron into a photon, in the presence of an enormous electric field intensity

Procedure

Note: the justifications and details of the following procedure are explained in the discussion section.

1) The system was assumed to consist of an electron incident in a uniform and constant electric field generated by a capacitor as in figure 3.

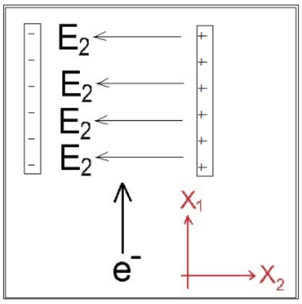

Figure 3: Arrival of the electron e- in an electric field E_2 generated by a capacitor. Where it is noted that E_2 only has component in x_2

2) It was assumed that the following reaction occurs when the electron is incident within the electric field (see its rationale in the comments section):

$$e^- + ╪ \rightarrow e^- + \gamma_{gamma} + ╪ \quad \textbf{(16)}$$

Where:

╪: symbolizes the capacitor.
e^-: symbolizes the electron and where before the reaction refers to the incident one and after the reaction to the one produced by transmutation.
γ_{gamma}: is a gamma-ray photon from ordinary three-dimensional space.

1) It was assumed that the reaction (16) decomposes as follows:

$$e^- + \gamma_v \rightarrow e^- + \gamma_{gamma} \quad \textbf{(a)}$$

and

$$╪ + \gamma_v \rightarrow ╪ \quad \textbf{(b)}$$

(17)

Where:
γ_v is the virtual photon that mediates the electromagnetic field and, in this case, the electric field between the

capacitor and the electron and which is the same, but at different instants, for both half reactions.

2) To model the electromagnetic interaction in the transmutation of the incident electron into a gamma ray photon of the half-reaction (17-a), the following assumptions were added:
   a) The impulse of the torque (14) is delivered in the form of quanta, that it is not deposited on the cuantex photon, to which the electron is equivalent, continuously throughout the movement of the electron.
   b) In order that the fourth component, that is the compact axis x_4, of the four-vector (4) is decomposed in the axes x_4 and x_5 of figure 2, a circular trajectory must be modeled, of this component, around the circle of the compact dimension.
   c) The cuantex model [1] assumes that there is a centripetal force F_H, with no component in x_1-x_2-x_3, implicit in the circular structure of the compact dimension and is given by:

$$F_H = \frac{2\,\pi\, m_e^2\, c^3}{h\gamma}$$

Then the following values were assigned in the expressions (4) and (10), which have to do with the Lorentz Four-force torque:

$B_2 = 0$, $B_3 = 0$, $E_1 = 0$, $E_3 = 0$,

$R_1 = \frac{v_1 h\, \gamma}{m_e\, c^2}$, $R_2 = 0$, $R_3=0$,

$R_4 = \frac{h}{2\,\pi\, m_e\, c} \operatorname{sen}\left(\frac{-2\,\pi\, m_e\, c^2}{h\gamma} t\right)$,

$R_5 = \frac{h}{2\,\pi\, m_e\, c} \cos\left(\frac{-2\,\pi\, m_e\, c^2}{h\gamma} t\right)$,

$F_1 = 0$, $F_2 = qE_2$, $F_3 = 0$,

$F_4 = qE_2 \operatorname{sen}\left(\frac{-2\,\pi\, m_e\, c^2}{h\gamma} t + \frac{\pi}{2}\right) + \frac{2\,\pi\, m_e^2\, c^3}{h\gamma} \operatorname{sen}\left(\frac{-2\,\pi\, m_e\, c^2}{h\gamma} t + \pi\right)$,

$F_5 = qE_2 \cos\left(\frac{-2\,\pi\, m_e\, c^2}{h\gamma} t + \frac{\pi}{2}\right) + \frac{2\,\pi\, m_e^2\, c^3}{h\gamma} \cos\left(\frac{-2\,\pi\, m_e\, c^2}{h\gamma} t + \pi\right)$.

Where:
m_e is the rest mass of the electron.
And also, the following values were assigned in the expression (11), which have to do with the angular momentum of the cuantex photon, to which the electron is equivalent, for the two parts of the half-reaction (17-a):
Initial values:

$P_{1i} = m_e v_1\, \gamma$, $P_{2i} = 0$, $P_{3i} = 0$, $P_{4i} = -m_e c$, $P_{5i} = 0$,
$r_{1i}=0$, $r_{2i}=0$, $r_{3i}=0$, $r_{4i}=0$, $r_{5i} = \frac{h}{2\,\pi\, m_e c}$,
Final values:

$P_{1f} = m_e v_1\, \gamma$, $P_{2f} =?$, $P_{3f} = 0$, $P_{4f} = 0$, $P_{5f} = 0$.

Note that $P_{4f} = 0$ indicates that in the final state of the reaction there is no longer an electron, but a photon [1] and that here P_{2f} is shown in incognito.

And finally

$r_{1f} = \frac{v_1 h\, \gamma}{m_e\, c^2}$, $r_{2f} = 0$, $r_{3f} = 0$, $r_{4f} = 0$, $r_{5f} = \frac{h}{2\,\pi\, m_e c}$.

Where it must be remembered that γ is the relativistic factor.

1) Once all these value assignments were considered, they were used in expression (14) focusing only on the vector component for x_2, assuming that the time interval of application of the torque is that of expression (15) and then solved for the magnitude of E_2.
2) The energy of the resulting gamma ray photon was calculated as a function of its linear momentum, which is composed of the values of P_{1f} and P_{2f} from step 4. To find P_{2f}, the assigned values from step 4 in expression (14) were used, focusing only on the vector component in x_3 and assuming that the time interval of application of the torque is that of expression (15).
3) The energy of the cuantex photon (K_e-produced), which is equivalent to the electron produced, was calculated assuming that the impulse on the incident electron is reflected as a reaction on the virtual photon, this impulse for the virtual photon being equal in magnitude, but opposite in direction. Without the need to apply rotational dynamics, the impulse that transmutes the virtual photon was obtained as follows:

   $\text{Impulse}_2 = -(P_{2f} - P_{2i})$

   $\text{Impulse}_4 = -(P_{4f} - P_{4i})$

   Where Impulse_2 and Impulse_4 is the x_2 and x_4 components of the impulse in reference.

4) It was established that the conservation of energy along the reaction (16), broken down in (17), must be fulfilled with the following expression:
   $K_{e\text{- incident}} + K_{\ddagger} + U_i = K_{e\text{-produced}} + K_{\gamma} + K_{\ddagger} + U_f$

   Where:

   $K_{e\text{- incident}}$: is the total energy of the incident electron.
   $K_{\ddagger}$: is the total energy of the capacitor.
   U_i and U_f are the initial and final electric potential energy, respectively, in the system.
   $K_{e\text{-produced}}$: is the total energy of the electron produced in the transmutation of the virtual photon.
   K_{γ}: is the energy of the gamma ray photon produced in the transmutation of the incident electron.
   And where the following values were assigned:
   $K_{e\text{- incident}} = m_e c^2\, \gamma$
   $K_{\ddagger}$: this value was kept in incognito because it was not needed.
   $U_f - U_i = -qE_2\, \Delta x_2$
   K_{γ}: the assigned value is the result of step 6.
   $K_{e\text{-produced}}$: the assigned value is the result of step 7.

From here, Δx_2 was cleared in the conservation equation to obtain the position difference in x_2 of the electron produced with respect to the position where the reaction started (16) and E_2 was substituted by the value given in the expression resulting from step (5).

Results

1) First, the equation formed in step 5 before assigning the torque and time values, is:

$$\int_0^t R_4 F_5 dt - \int_0^t R_5 F_4 dt = r_{5i} P_{4i}$$

And in the end, it turns out that the magnitude of the electric field necessary to achieve the reaction (16) is:

$$|E_2| = \frac{m_e^2 c^3}{h |q| \gamma} \quad \textbf{(18)}$$

2) In step 6 the equation that is formed before assigning the values of torque and time, to find the value of P_{2f} is:

$$\int_0^t R_4 F_5 dt - \int_0^t R_5 F_4 dt + r_{1f} q E_2 \int_0^t dt = r_{1f} P_{2f} - (-r_{5i} P_{4i})$$

And then it was found that the energy of the resulting gamma-ray photon γ_{gamma} is:

$$K_\gamma = m_e c^2 \gamma$$

3) In step 7 the value of the energy of the electron produced was obtained (more exactly the energy of the cuantex photon to which this electron is equivalent):

$$K_{e\text{-produced}} = \sqrt{2}\, m_e c^2$$

4) In step 8 the difference of position in x2 of the electron produced, with respect to the position where the reaction takes place, was obtained:

$$\Delta x_2 = \frac{\sqrt{2}\, h}{m_e c}$$

5. Discussions

1) The following figure illustrates what happens in the reaction (16):

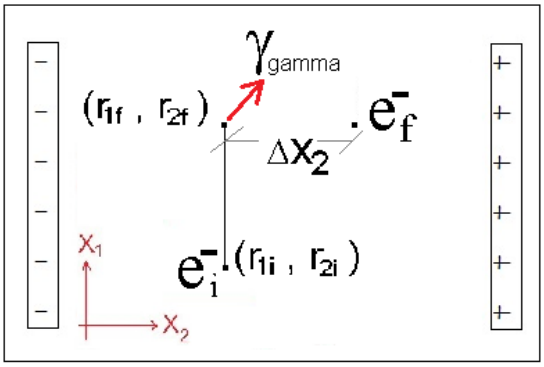

Figure 4: Illustration showing the initial and final position of step 4 along the reaction (16) and the distance in x_2 where the electron to which the virtual photon transmutes appears. Here e_i^- and e_f^- are the initial electron and the final electron.

This figure shows some of the values discussed in step 4 and shows that the path taken by the cuantex photon, which is equivalent to the initial electron, while it is subjected to the reaction, is along its initial trajectory. It also shows the gamma ray photon to which the initial electron (e_i^-) transmutes and the position in x_2 where the produced electron (e_f^-) appears.

2) Regarding the reaction (16), the electron of the first part is the incident one in the electric field of figure 3, however, in the second part this electron has transmuted to the gamma ray photon γ_{gamma} and the new electron that appears is the product of the transmutation of the virtual photon γ_v, of the partial reactions (17), in this electron. In more detail, the component in the compact dimension of the Lorentz four-force (4) was manifested by a positive impulse on the compact axis, on the cuantex photon to which the incident electron is equivalent, stopping its rotation (that is, this cuantex photon initially travels in a negative direction on the compact axis) on the compact axis and immersing it totally in the ordinary space of three dimensions (x_1-x_2-x_3), which would be known as a gamma ray photon. As a reaction to this, the virtual photon receives the same impulse (in point 3 it is explained why the reaction is on this photon) within the time interval in which it exists, but in the opposite direction, that is, in a negative direction on the compact axis and therefore becomes a cuantex photon to which the new electron of the second part of the reaction (16) is equivalent.

3) The reason why the virtual photon receives the impulse mentioned in point 2, is because in the partial reaction (17-B) the capacitor ╪ does not receive any effect and remains intact. This is due to the fact that the reaction is received by the virtual photon in its place because the impulse of the Lorentz four-force (4) that as a reaction would be directed to the capacitor is insufficient to cause transmutation in any of its particles, since the elementary unit of the capacitor would be formed by a proton (positive charge) and an electron (negative charge) and this pair could not be transmuted by this very weak impulse, to which the incident electron reacts. In other words, the virtual photon does not reach the capacitor because it is first transmuted into an electron.

4) It can be observed that the reaction (16) conserves the lepton number and the electric charge. Although it is not demonstrated here, in the cuantex model these two conservations are derived from a single conservation and that is the conservation of the amount of linear motion of cuantex photons when subjected to particle reactions.

5) In expression (18) it is observed that the magnitude of the electric field necessary to transmute an electron in a gamma ray photon depends on the speed with which the electron affects this field. The closer the speed of the electron to the speed of light, the smaller the required electric field and vice versa. In this regard, it can be observed that if the incident electron speed is 99.99% of that of light, then the magnitude of E_2 takes the value of 2.978×10^{15} V/m and if it is 10% of that of light or less then this magnitude must be at least 2.096×10^{17} V/m, which are very high values that have not yet been able to be generated artificially in a laboratory. In this and the following calculations the constants were obtained from "CRC Handbook of Chemistry and Physics" [6].

6) The result 4, corresponding to step 8, implies that the electron produced in the reaction (16) appears in a position whose coordinate in x_2 is displaced Δx_2 to the right (see figure 4) with respect to the position where the cuantex photon interacts with the incident electron and the virtual photon of the electric field. That is, this produced electron appears at a lower electric potential.

The mechanism that achieves this is the travel of the virtual photon to that position while it transmutes, in a time shorter than that imposed by the uncertainty principle.

Reaction that transmutes the electron into a positron, in the presence of an enormous electric field intensity.

Procedure

1) The system was assumed to consist of an electron incident in a uniform and constant electric field generated by a capacitor as in figure 3.
2) It was assumed that the following reaction occurs when the electron is incident within the electric field (see its rationale in the comments section):

$$e^- + \text{ǂ} \rightarrow e^- + e^- + e^+ + \text{ǂ} \qquad \textbf{(19)}$$

Where:

e^+ symbolizes the positron produced.

Note that before the reaction there is one incident electron and after the reaction there are two produced by transmutation.

3) It was assumed that the reaction (19) decomposes as follows:

$$e^- + \gamma_V \rightarrow e^- + e^- + e^+ \qquad \textbf{(a)}$$

and

$$\text{ǂ} + \gamma_V \rightarrow \text{ǂ} \qquad \textbf{(b)}$$

(20)

4) To achieve reaction (20-a) all the exact same steps of procedure 4 for the section dealing with the reaction that transmutes the electron into a photon are repeated, except for the value assigned for P_{4f} which will now be:

$$P_{4F} = m_e\, c$$

5) Once all these value assignments were considered, they were used in expression (14) focusing only on the vector component for x_2, assuming that the time interval of torque application is that of expression (15) and got the solution for the magnitude of E_2.

6) The energy of the cuantex photon that the resulting positron is equivalent to was calculated, as a function of the magnitude of its linear momentum and which is composed of the values of P_{1f}, P_{2f} and P_{4f} of step 4. The assigned values from step 4 in expression (14) were used to find P_{2f}, focusing only on the vector component in x_3 and assuming that the time interval of torque application is that of expression (15).

7) The energy of the cuantex photon ($K_{e\text{-produced}}$), which is equivalent to each electron produced, was calculated assuming that the impulse on the incident electron is reflected as a reaction on the virtual photon, this impulse for the virtual photon being equal in magnitude, but opposite in direction. Without the need to apply rotational dynamics, the impulse that transmutes the virtual photon was obtained as follows:

$$\text{Impulse}_2 = -(P_{2f} - P_{2i})/2$$

$$\text{Impulse}_4 = -(P_{4f} - P_{4i})/2$$

Where Impulse_2 and Impulse_4 are half the x_2 and x_4 components of the impulse in reference.

8) It was established that the conservation of energy along the reaction (19), broken down in (20), must be fulfilled with the following expression:

$$K_{e\text{- incidente}} + K_{\text{ǂ}} + U_i = 2K_{e\text{-producido}} + K_{e+\text{producido}} + K_{\text{ǂ}} + U_f$$

Where the only new symbolism is explained below:

$K_{e+\text{produced}}$: is the total energy of the positron produced calculated in step 6.

And where the following values were assigned:

$K_{e\text{- incident}} = m_e c^2\, \gamma$

$K_{\text{ǂ}}$: this value was kept in incognito because it was not needed.

From here, Δx_2 was cleared in the conservation equation to obtain the position difference in x_2 of the electrons produced with respect to the position where the reaction started (19) and E_2 was substituted by the value given in the expression resulting from step (5).

Results

1) First, the equation formed in step 5 before assigning the torque and time values, is:

$$\int_0^t R_4\, F_5 dt - \int_0^t R_5\, F_4 dt + \int_0^t R_3\, F_1 dt - \int_0^t R_1\, F_3 dt = -\left(\frac{h}{2\pi} + \frac{h}{2\pi}\right)$$

And in the end, it turns out that the magnitude of the electric field necessary to achieve the reaction (19) is:

$$|E_2| = \frac{2m_e^2\, c^3}{h\, |q|\, \gamma} \qquad \textbf{(21)}$$

2) In step 6 the equation that is formed before assigning the values of torque and time, to find the value of P_{2f} is:

$$\int_0^t R_4\, F_5 dt - \int_0^t R_5\, F_4 dt + r_{1f}\, qE_2 \int_0^t dt = -r_{5f}P_{4f} + r_{1f}P_{2f} - (-r_{5i}P_{4i})$$

P_{2f} was found to be:

$P_{2f} = 2m_e c$

And then the energy of the positron that was produced was found to be:

$$K_{e^+\text{-produced}} = m_e c^2 \sqrt{5 + \frac{v_1^2}{c^2}\gamma^2} \qquad \textbf{(22)}$$

3) In step 7 the value of the energy of each electron produced was obtained (more exactly the energy of the cuantex photon to which each electron is equivalent):

$$K_{e\text{-produced}} = \sqrt{2}\, m_e c^2$$

4) In step 8 the difference of position in x_2 of each electron produced, with respect to the position where the reaction takes place, was obtained:

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$$\Delta x_2 = \frac{h\gamma\left(\gamma - \sqrt{5 + \frac{v_1^2}{c^2}\gamma^2 - 2\sqrt{2}}\right)}{-4m_e c}$$

Where it is noted that the result of this expression will always have a positive value.

Discussions

1) The following figure illustrates what happens in the reaction (19):

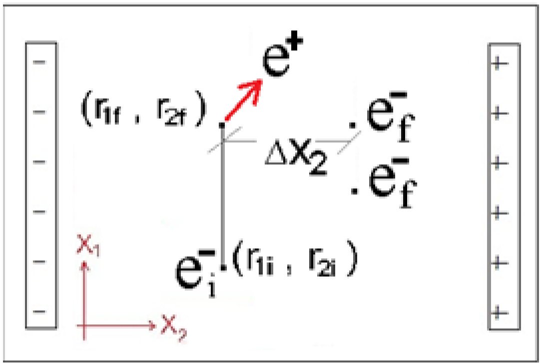

Figure 5: Illustration showing the initial and final position of step 4 along the reaction (19) and the distance in x_2 where the electrons to which the virtual photon transmutes appears. Here e_i^- and e_f^- are the initial electron and the final electron.

This figure shows some of the values discussed in step 4 and shows that the path taken by the cuantex photon, which is equivalent to the initial electron, while it is subjected to the reaction, is along its initial trajectory. It also shows the positron (e^+) to which the initial electron (e_i^-) transmutes and the position in x_2 where the produced electrons (e_f^-) appears.

2) Regarding the reaction (19), the electron of the first part is the incident one in the electric field of figure 3, however, in the second part this electron has transmuted to the positron and the new electrons that appears is the product of the transmutation of the virtual photon γ_v, of the partial reactions (20), in these electrons. In more detail, the component in the compact dimension of the Lorentz four-force (4) was manifested by a positive impulse on the compact axis, on the cuantex photon to which the incident electron is equivalent, reversing its rotation (that is, this cuantex photon initially travels in a negative direction on the compact axis) on the compact axis and rotating it in a positive direction. As a reaction to this, the virtual photon receives the same impulse (in point 3 it is explained why the reaction is on this photon) within the time interval in which it exists, but in the opposite direction, that is, in a negative direction on the compact axis and thus becomes two cuantex photons to which the new electrons of the second part of the reaction are equivalent (19).

3) The reason why the virtual photon receives the impulse mentioned in point 2, is because in the partial reaction (20-B) the capacitor ╪ does not receive any effect and remains intact. This is due to the fact that the reaction is received by the virtual photon in its place because the impulse of the Lorentz four-force (4) that as a reaction would be directed to the capacitor is insufficient to cause transmutation in any of its particles, since the elementary unit of the capacitor would be formed by a proton (positive charge) and an electron (negative charge) and this pair could not be transmuted by this very weak impulse, to which the incident electron reacts. In other words, the virtual photon does not reach the capacitor because it is first transmuted into an electron.

4) It can be observed that the reaction (19) conserves the lepton number and the electric charge.

5) In the expression (21) it can be observed that it is equal to (18) except for the factor of 2. If the incident electron speed is 99.99% of that of light, then the magnitude of E_2 takes the value of 5.957 x 10^{15} V/m and if it is 10% of that of light or less then the magnitude must be at least 4.191 x 10^{17} V/m.

6) The result 4, corresponding to step 8, implies that the electrons produced in the reaction (19) appears in a position whose coordinate in x_2 is displaced Δx_2 to the right (see figure 5) with respect to the position where the cuantex photon interacts with the incident electron and the virtual photon of the electric field. That is, these electrons produced appears at a lower electric potential. The mechanism that achieves this is the travel of the virtual photon to that position while it transmutes, in a time shorter than that imposed by the uncertainty principle.

Reaction that transmutes the electron into an anti-muon, in the presence of an enormous electric field intensity.

Procedure

1) The system was assumed to consist of an electron incident in a uniform and constant electric field generated by a capacitor as in figure 3.

2) It was assumed that the following reaction occurs when the electron is incident within the electric field (see its rationale in the comments section):

$$e^- + ╪ \rightarrow e^- + \mu^- + \mu^+ + ╪ \qquad \textbf{(23)}$$

Where:

μ^- and μ^+ symbolizes the muon and anti-muon produced, respectively.

Note that before the reaction there is an incident electron and after the reaction there is one produced by transmutation.

3) It was assumed that the reaction (23) decomposes as follows:

$$e^- + \gamma_v \rightarrow e^- + \mu^- + \mu^+ \qquad \textbf{(a)}$$

and

$$╪ + \gamma_v \rightarrow ╪ \qquad \textbf{(b)}$$

(24)

4) The same assumptions of step 4 of section dealing with the reaction that transmutes the electron into a photon are repeated were made and the following assumption was added: the quantum nature of the energy transmission, it was concluded that the necessary impulse for the reaction (23) implies a quantum jump of the cuantex photon to which the electron is equivalent, to the compact dimension of the muon and anti-muon.

All the above led to the following value assignment:

$B_2 = 0$, $B_3 = 0$, $E_1 = 0$, $E_3 = 0$,

$R_1 = \frac{v_1 h \gamma}{m_\mu c^2}$, $R_2 = 0$, $R_3 = 0$,

$R_4 = \frac{h}{2\pi m_\mu c} \operatorname{sen}\left(\frac{-2\pi m_\mu c^2}{h\gamma} t\right)$,

$R_5 = \frac{h}{2\pi m_\mu c} \cos\left(\frac{-2\pi m_\mu c^2}{h\gamma} t\right)$,

$F_1 = 0$, $F_2 = qE_2$, $F_3 = 0$,

$F_4 = qE_2 \operatorname{sen}\left(\frac{-2\pi m_\mu c^2}{h\gamma} t \frac{\pi}{2}\right) + \frac{2\pi m_\mu^2 c^3}{h\gamma} \operatorname{sen}\left(\frac{-2\pi m_\mu c^2}{h\gamma} t + \pi\right)$,

$F_5 = qE_2 \cos\left(\frac{-2\pi m_\mu c^2}{h\gamma} t + \frac{\pi}{2}\right) + \frac{2\pi m_\mu^2 c^3}{h\gamma} \cos\left(\frac{-2\pi m_\mu c^2}{h\gamma} t + \pi\right)$.

Where:

m_μ is the rest mass of the muon.

For the expression (11), initial and final values were determined for the reaction in the electron within the electric field.

Initial values:

$P_{1i} = m_e v_1 \gamma$, $P_{2i} = 0$, $P_{3i} = 0$, $P_{4i} = -m_e c$, $P_{5i} = 0$,
$r_{1i} = 0$, $r_{2i} = 0$, $r_{3i} = 0$, $r_{4i} = 0$, $r_{5i} = \frac{h}{2\pi m_\mu c}$,

Final values:

$P_{1f} = m_e v_1 \gamma$, $P_{2f} = ?$, $P_{3f} = 0$, $P_{4f} = m_\mu c$, $P_{5f} = 0$,

And finally
$r_{1f} = \frac{v_1 h \gamma}{m_\mu c^2}$, $r_{2f} = 0$, $r_{3f} = 0$, $r_{4f} = 0$, $r_{5f} = \frac{h}{2\pi m_\mu c}$.

5) Once all these value assignments were considered, they were used in expression (14) focusing only on the vector component for x_2, assuming that the time interval of torque application is that of expression (15) and got the solution for the magnitude of E_2.
6) The energy of the cuantex photon that the resulting anti-muon is equivalent to was calculated, as a function of the magnitude of its linear momentum and which is composed of the values of P_{1f}, P_{2f} and P_{4f} of step 4. The assigned values from step 4 in expression (14) were used to find P_{2f}, focusing only on the vector component in x_3 and assuming that the time interval of torque application is that of expression (15).
7) The energy of the cuantex photon ($K_{e\text{-produced}}$), which is equivalent the electron produced, and the muon produced, was calculated assuming that the impulse on the incident electron is reflected as a reaction on the virtual photon, this impulse for the virtual photon being equal in magnitude, but opposite in direction. Without the need to apply rotational dynamics, the impulse that transmutes the virtual photon into each of the above-mentioned particles was achieved as follows:

for the electron:
$\text{Impulse}_2\text{-}e^- = -(P_{2f} - P_{2i}) - \text{Impulse}_2\text{-}\mu^-$
$\text{Impulse}_4\text{-}e^- = -(P_{4f} - P_{4i}) - \text{Impulse}_4\text{-}\mu^-$
And for the muon:
$\text{Impulse}_2\text{-}\mu^- = -(P_{2f} - P_{2i}) - \text{Impulse}_2\text{-}e^-$
$\text{Impulse}_4\text{-}\mu^- = -(P_{4f} - P_{4i}) - \text{Impulse}_4\text{-}e^-$

Where:
$\text{Impulse}_2\text{-}e^-$ and $\text{Impulse}_4\text{-}e^-$ are the x_2 and x_4 components of the part of the impulse on the virtual photon that transforms it into an electron.

$\text{Impulse}_2\text{-}\mu^-$ and $\text{Impulse}_4\text{-}\mu^-$ are the x_2 and x_4 components of the part of the impulse on the virtual photon that transforms it into a muon.

8) It was established that the conservation of energy along the reaction (23), broken down in (24), must be fulfilled with the following expression:

$K_{e\text{- incident}} + K_{\ddagger} + U_i =$
$K_{e\text{-produced}} + K_{\mu-\text{ produced}} + K_{\mu+\text{ produced}} + K_{\ddagger} + U_f$

Where:
$K_{\mu-\text{ produced}}$: is the total energy of the produced muon.
$K_{\mu+\text{ produced}}$: is the total energy of the anti-muon produced.
And where the following values were assigned:
$K_{e\text{- incident}} = m_e c^2 \gamma$
$K_{\ddagger}$: this value was kept in incognito because it was not needed.
$U_f - U_i = -2qE_2 \Delta x_2$
$K_{e\text{-producido}}$: the assigned value is the result of step 7.

From here, Δx_2 was cleared in the conservation equation to obtain the position difference in x_2 of the electron and muon produced with respect to the position where the reaction started (23) and E_2 was substituted by the value given in the expression resulting from step (5).

Results

1) First, the equation formed in step 5 before assigning the torque and time values, is:

$$\int_0^t R_4 F_5 dt - \int_0^t R_5 F_4 dt + \int_0^t R_3 F_1 dt - \int_0^t R_1 F_3 dt = -\left(\frac{h}{2\pi} + \frac{h}{2\pi}\frac{m_e}{m_\mu}\right)$$

And in the end, it turns out that the magnitude of the electric field necessary to achieve the reaction (23) is:

$$|E_2| = \frac{m_\mu c^3}{h\,|q|\gamma}(m_\mu + m_e) \qquad \textbf{(25)}$$

2) In step 6 the equation that is formed before assigning the values of torque and time, to find the value of P_{2f} is:

$\int_0^t R_4 F_5 dt$ - $\int_0^t R_5 F_4 dt$ + $r_{1f} qE_2 \int_0^t dt$ = $-r_{5f}P_{4f}$ + $r_{1f}P_{2f}$ - $(-r_{5i}P_{4i})$

Next, it was found that P_{2f} is:

$$P_{2f} = \frac{-m_\mu^2 c^2 + 2\pi m_\mu^2 c v_1 \gamma + 2\pi m_\mu m_e c v_1 \gamma + m_e^2 c^2}{2\pi m_e v_1 \gamma}$$

And then it was found that the energy of the anti-muon produced is:

$$K_{\mu+ \text{ producido}} = \sqrt{P_{2f}^2 + (m_\mu c)^2}\ c$$

3) In step 7 the value of the energy of the electron produced was obtained (more exactly the energy of the cuantex photon to which this electron is equivalent):
$K_{e\text{-produced}} = \sqrt{2}\, m_e c^2$

And the energy of the produced muon was also found:
$K_{\mu-\text{ produced}} = \sqrt{2}\, m_\mu c^2$

4) In step 8 the difference of position in x_2 of the electron and muon produced, with respect to the position where the reaction takes place, was obtained:

$$\Delta x_2 = \frac{m_e c^2 \gamma - \sqrt{2}\, m_e c^2 - \sqrt{2}\, m_\mu c^2 - \sqrt{P_{2f}^2 + (m_\mu c)^2}\ c}{-2|q|E_2}$$

Discussions

1) Regarding the reaction (23), the electron of the first part is the incident one in the electric field of figure 3, however, in the second part this electron has transmuted to the anti-muon and the new electron and muon that appears is the product of the transmutation of the virtual photon γ_v, of the partial reactions (23), in these particles. In more detail, the component in the compact dimension of the Lorentz four-force (4) was manifested by a positive impulse on the compact axis, on the cuantex photon to which the incident electron is equivalent, reversing its rotation (that is, this cuantex photon initially travels in a negative direction on the compact axis) on the compact axis and rotating it in a positive direction. As a reaction to this, the virtual photon receives the same impulse (in point 2 it is explained why the reaction is on this photon) within the time interval in which it exists, but in the opposite direction, that is, in a negative direction on the compact axis and therefore becomes the cuantex photons equivalent to one electron and one muon in the second part of the reaction (23).
2) The reason why the virtual photon receives the impulse mentioned in point 1, is because in the partial reaction (24-B) the capacitor ╪ does not receive any effect and remains intact. This is due to the fact that the reaction is received by the virtual photon in its place because the impulse of the Lorentz four-force (4) that as a reaction would be directed to the capacitor is insufficient to cause transmutation in any of its particles, since the elementary unit of the capacitor would be formed by a proton (positive charge) and an electron (negative charge) and this pair could not be transmuted by this very weak impulse, to which the incident electron reacts. In other words, the virtual photon does not reach the capacitor because it is first transmuted into an electron.
3) It can be observed that the reaction (19) conserves the lepton number and the electric charge.
4) If the incident electron speed is 99.99% of that of light, then the magnitude of E_2 takes the value of 1.28 x 10^{20} V/m and if it is 10% of that of light or less then the magnitude must be at least 9 x 10^{21} V/m.

6. Conclusions

1) Although in this paper the transformation of one particle into another is called transmutation, from the perspective of the cuantex model such transmutations are nothing more than changes in the directions of motion of the cuantex photons to which the particles with rest mass are equivalent or change in the compact dimension as in the case of the transmutation to anti muon.
2) It can be observed in the expression (11) that when substituting the values for r_4, p_5, r_5 and p_4, then results the value of $h/(2\pi)$ which remains constant independently of the position of the cuantex photon, to which the electron is equivalent, in the compact dimension (the circle in the figure 1 and 2) and independently of if the electron moves or is at rest and which is the quantum angular momentum of the quantum mechanics and therefore the intrinsic angular momentum that finally derives in the spin of an elementary particle with rest mass.
3) It can be said that when there is only an electric field produced by a capacitor equivalent system and the speed of the incident electron is 10% of that of light, then the following are the lower and upper levels of the electric field for the described transmutations:

   [2.096 x 10^{17}, 4.191 x 10^{17}) V/m to transmute to photon.

   [4.191 x 10^{17}, 9 x 10^{21}) V/m to transmute to positron.

   Within each of these intervals the electric field only increases the magnitude of the x_1-x_2-x_3 component of the four-momentum (5).

4) The same procedure applied for electron transmutation to anti-muon would be applied for electron transmutation to anti muon.
5) In this paper three cases were analyzed in which the electric field is perpendicular to the direction in which the electron is incident on said field. However, if it is desired to generalize the value of the minimum electric field to transmute, independently of the direction of incidence of the electron, then for the expressions (18), (21) and (25) E_2 is replaced by the fourth component of the vector of the expression (4), then a little algebra is done, and it is obtained:

$$|E| = \frac{m_e^2 c^3}{h\,|q|}\ [1-(1-\gamma^2)(\cos^2\theta_2 + \cos^2\theta_3)]^{-1/2}$$

For the minimum electric field necessary for the electron to transmute to a photon.

$$|E| = \frac{2m_e^2 c^3}{h\,|q|}\,[1-(1-\gamma^2)(\cos^2\theta_2 + \cos^2\theta_3)]^{-1/2}$$

For the minimum electric field necessary for the electron to transmute to a positron.

$$|E|=\frac{m_\mu c^3}{h\,|q|}(m_\mu+m_e)[1-(1-\gamma^2)(\cos^2\theta_2 + \cos^2\theta_3)]^{-1/2}$$

For the minimum electric field necessary for the electron to transmute to a anti muon.

And where θ_2 and θ_3 are the angles respect to x_2 and x_3 that form the electric field E.

6) Obviously, the electric fields necessary to demonstrate these results are extremely enormous and can hardly be produced in laboratories. However, the author of this research is developing a system to patent that achieves extremely small regions where it is possible to produce such fields extremely cheaply and thus test this whole theory and if positive results are obtained, then produce positrons unlimitedly for a subsequent annihilation reaction with a free electron current and as a result generate unlimited clean energy. Researchers wishing to join this project may contact the author's profile on the ResearchGate site or by one of the e-mail addresses listed at the beginning of this document.

References

[1] Alcerro-Mena JC (2018). Euclidean equivalent of Minkowski's space-time theory and the corresponding model of elementary particles ("cuantex" model). Journal of Physics and Astronomy Research, 4(1): 079-086.

[2] Rindler, Wolfgang. Introduction to special relativity. (2 edition). Oxford: Oxford University Press. ISBN 0-19-853953-3.

[3] R. A. Serway, J. W. Jewett, 2008. "*Physics for Scientists and Engineers*". Volume 1, Seventh Edition. Brooks/Cole. ISBN: 0-495-11243-7.

[4] Griffiths David, Introduction to elementary particles, John Wiley&Sons, Inc. (first edition), ISBN 0-471-60386-4.

[5] M.A. Murray-Lasso, Ingeniería Investigación y Tecnología, ISSN 2594-0732 V.1, 27-47, 2004.

[6] David R. Lide, Handbook of Chemistry and Physics, National institute of Standards and technology. Internet Version 2005.